CHROMOSOME CYTOLOGY OF BRUNIACEAE[1]

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ABSTRACT

The chromosome numbers are reported for twenty-one species in eight genera of Bruniaceae, a small family almost entirely restricted to the Cape Floristic Region of South Africa, an area with a very distinctive flora. With the only previous count in the family disregarded, a base number of $x = 11$ is suggested as fundamental in the family. A diploid number of $2n = 22$ is recorded in the monotypic and apparently primitive *Audouinia*. Other genera counted evidently have a base number in the $x = 20$–23 range and thus may be palaeopolyploid in comparison to *Audouinia*. *Staavia*, *Raspalia* and *Lonchostoma* have $x = 22$, with the widespread *S. radiata* tetraploid, $2n =$ ca. 88. Exact base numbers in the remaining genera examined are uncertain owing to difficulties in counting: ***Pseudobaekia*** has $n =$ ca. 22; *Nebelia* $n = 22$ and ca. 23; *Brunia* $n =$ ca. 20 and 23; and ***Berzelia*** $n = 20$ and ca. 21. ***Berzelia*** *ecklonii* and ***B.*** *abrotanoides* are tetraploid, $n = 80$–88, while ***B.*** *intermedia* has diploid, tetraploid and hexaploid races.

INTRODUCTION

The Bruniaceae is a small family of twelve genera and between seventy and eighty species, endemic in South Africa. All but a few species occur only in the Cape Floristic Region in the extreme southwestern part of the Cape Province, an area of predominantly mediterranean climate. The family consists of medium to small sized shrubs, almost all with sclerophyllous ericoid leaves, and it forms a very characteristic element of the flora. This survey of the cytology of the family was undertaken in collaboration with Mrs. E. Powrie, who began a systematic revision of the family some ten years ago, a study cut short by her recent death. Our initial hope, that cytological data would provide data of help in determining generic and family relationships, has not been realized; however, the information obtained so far seems worth publishing for itself, and it may be of use to others in the future.

MATERIALS AND METHODS

Chromosome studies were made from both mitotic and meiotic material. Mitotic chromosome counts were obtained from root tips of seedlings cultivated by Powrie in South Africa, and at the Missouri Botanical Garden. All seed was collected in the wild. Both paraffin section (Goldblatt, 1971) and squash techniques (Goldblatt, 1976, 1979) were employed. In the latter case root tips were pretreated in 0.1% aqueous colchicine or in hydroxyquinoline solution, both stored overnight at refrigerator temperature, before fixing. After acid hydrolysis, root tips were stained in lacto-propionic orcein.

Meiotic counts were made from anther squashes, all flower buds being collected wild. Vouchers are deposited at the Bolus Herbarium (BOL), University

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of Cape Town, South Africa, Missouri Botanical Garden (MO), St. Louis, Missouri or at Rancho Santa Ana Botanical Garden (RSA), California.

Results

The putatively primitive (Pillans, 1947) monotypic *Audouinia* has $n = 11$ (Table 1), making it the only genus of the eight counted with a chromosome number at the palaeodiploid level.

Two species of *Lonchostoma* counted, one of *Pseudobaekia,* two of *Raspalia* and three of *Staavia,* have $n = 22$ or ca. 22, while the only common and widespread species of *Staavia, S. radiata* is tetraploid, $2n =$ ca. 88.

Species of *Nebelia* and the closely allied *Brunia* are, like the previous genera, basically tetraploid, with haploid numbers in the range $n = 20, 22, 23$. I have obtained counts of $2n = 40$ or ca. 40 in *Brunia albiflora* and *B. stokoei* but $2n = 46$ in *B. nodiflora.* Counts in *Nebelia* are $2n =$ ca. 44 for *N. paleacea* and *N. fragarioides,* while *N. stokoei* has $2n =$ ca. 46.

In the apparently most advanced genus *Berzelia,* most species have $n = 20$ (ca. 20, ca. 21) but *B. ecklonii* and *B. abrotanoides* are neotetraploid, $n =$ ca. 40, while *B. intermedia,* the most widespread species of the genus, has races with $n =$ ca. 20, ca. 80–86, and ca. 120.

Chromosomes of all species examined are similar and uniformly small, ranging in size at mitotic metaphase from 1.5–2.5 μm. Small size combined with high number has made it difficult to obtain accurate counts in several species.

The only previous count in Bruniaceae apart from a summary of present results given by Raven (1975), is a record of $n =$ ca. 8 (Saxton, 1970) in *Staavia glutinosa* obtained incidentally in the course of an embryological study. This report is almost certainly incorrect.

Discussion

The most striking observation resulting from this study is the sharp difference in basic ploidy level between *Audouinia* and the seven other genera examined. *Audouinia* is apparently the most primitive genus of Bruniaceae, a relict of very limited distribution, and the only genus with a trilocular ovary. It is the only diploid encountered in this study, thus standing in isolation cytologically from base numbers of $x = 20–23$ in the other genera studied.

Most closely allied to *Audouinia,* of those genera examined, are *Pseudobaekia* and *Lonchostoma,* which also have axillary inflorescences, but a bilocular (–unilocular) ovary. *Lonchostoma* and *Pseudobaekia* as well as *Staavia* and *Raspalia* (capitate inflorescences) have $x = 22$.

Nebelia and *Brunia* are closely related (Powrie, pers. comm.), perhaps not generically separable, and these, together with *Berzelia* form a distinctive group of Bruniaceae, seemingly well separated from the other genera. All have globose, capitate inflorescences. *Brunia* (bilocular to unilocular ovaries) and *Nebelia* (unilocular ovaries) have dehiscent fruits (according to Pillans, 1947), while *Berzelia,* also with unilocular ovaries, have indehiscent fruits. These genera are also tetraploid in comparison with *Audouinia,* but unfortunately, owing to difficulties in making accurate counts, the exact base number has not been determined. I am

TABLE 1. Chromosome numbers in Bruniaceae—All localities are in the Cape Province, South Africa.

Species	Chromosome Number *n*	Chromosome Number 2*n*	Collection Data
Audouinia			
A. capitata (L.) Brongn.	11		Cape Point Reserve, *Goldblatt 1844* (MO)
		22	Karbonkelberg, Cape Peninsula, *Powrie 255* (BOL)
Lonchostoma			
L. purpureum Pill.	22		Somerset Sneeukop, *Goldblatt 1646* (MO)
L. monogynum (Vahl.) Pill.	22		DuToit's Kloof Mts., *Goldblatt 2071* (MO)
		ca. 44	Buffelshoek, Ceres, *Esterhuysen 32676* (BOL)
Pseudobaekia			
P. africana (Bwm. f.) Pillans		ca. 44	Vogelgat, Hermanus, *Goldblatt 5345* (MO)
Staavia			
S. capitella (Thunb.) Sond.	22–23		Silverstream, Villiersdorp, *Goldblatt 1813* (MO)
S. zeyheri Sond.	22–23		Near Riviersonderend, *Goldblatt 2061* (MO)
S. doddii H. Bolus		ca. 44	Cape Point Reserve, *Goldblatt 1845* (MO)
S. radiata (L.) Dahl.		ca. 88	Cape Point Reserve, *Powrie s.n.* no voucher
		ca. 88	Sandveld near Darling, *Powrie s.n.* no voucher
Raspalia			
R. globosa (Lam.) Pillans		ca. 44	Nuweberg Reserve, *Powrie 42* (BOL)
R. microphylla (Thunb.) Brongn.	ca. 22		Rooi Els, *Powrie s.n.* no voucher
Nebelia			
N. fragarioides (Willd.) O. Kuntze		ca. 44	Rooi Els, *Powrie s.n.* no voucher
N. paleacea (Berg.) Sweet	ca. 22		Rooi Els, *Carlquist 4780* (RSA)
N. stokoei Pillans		ca. 46	Hex R. Mts., W. Milner Peak *Carlquist 5022* (RSA)
Brunia			
B. albiflora Phill.		40	Stalberg, Rooi Els, *Powrie s.n.* no voucher
		ca. 40	Vogelgat, Hermanus, *Carlquist 4535* (RSA)
B. nodiflora L.		46	Cape Prov., *Carlquist 4608* (RSA)
B. stokoei Phill.		ca. 40	Rooi Els, *Powrie s.n.* no voucher
Berzelia			
B. abrotanoides (L.) Brongn.		ca. 80	Vyeboom, *Powrie 148* (BOL)
		ca. 80	Cape Point Reserve, *Powrie s.n.* no voucher
var. *pilosa* (L.) Brongn.		ca. 80	Kraaifontein, *Powrie 127* (BOL)
B. burchellii Dummer		40	Garcias Pass, *Powrie 151* (BOL)
B. ecklonii Pillans		ca. 80–86	Rooi Els, *Carlquist 4965* (RSA)
B. galpinii Pillans		40	Garcias Pass, *Carlquist 4541* (RSA)
		ca. 40	Garcias Pass, *Powrie 153* (BOL)
		ca. 40	Near Muisrkaal, Grootwaterval, *Powrie s.n.* no voucher
B. intermedia Schldl.		ca. 42	Natures Valley, *Powrie s.n.* no voucher
		42	Garcias Pass, *Carlquist 4742* (RSA)
		ca. 80–86	Swellendam, *Powrie s.n.* no voucher
		ca. 80–86	Albertinia, *Powrie 254* (BOL)
		ca. 80–86	Robinsons Pass, *Powrie s.n.* no voucher

TABLE 1. Continued.

Species	Chromosome Number *n*	Chromosome Number 2*n*	Collection Data
		ca. 120	Arrieskrall, Palmiet River Valley, *Powrie s.n.* no voucher
B. lanuginosa (L.) Brongn.		40	Stalberg, Rooi Els, *Powrie s.n.* no voucher
B. rubra (Willd.) Schldl.		ca. 40	Maanskyn Kop, Hermanus, *Powrie 244* (BOL)

therefore uncertain whether the apparent diversity of numbers in *Brunia* and *Berzelia* is correct. The count of $n = 22$ in *Nebelia* seems reasonable in view of the same number having been recorded in four other genera and $n =$ ca. 23 in *N. stokoei* may be incorrect or due to the presence of supernumeraries. The counts of $n = 20$ and ca. 20 in *Brunia* were obtained after long, careful observation and I had no reason at the time to doubt them. However, my count of $n = 23$ in my material of *B. nodiflora* is almost certainly correct but whether due to supernumeraries cannot yet be determined.

Berzelia from my observations almost certainly has $x = 20$, although some higher counts were made in *B. intermedia*, $n =$ ca. 21. Interestingly, in this most specialized genus, there are cases of neopolyploidy. Four of the species examined are diploid, two tetraploid, and one, *B. intermedia*, has diploid, tetraploid and hexaploid forms. In this widespread species, eastern populations are tetraploid, the most western population counted is hexaploid, while the two diploids were collected in about the middle of the range.

In summary, the pattern suggested from the available information is the following. Bruniaceae may have a basic number for the family of $x = 11$. *Audouinia* stands out as an isolated diploid relict compared with the other genera, all tetraploid on the base $x = 11$ or 10. Exact counts were not obtained in *Brunia* and *Nebelia*, which may have $n = 20$ and 23, and $n = 22$ and 23 respectively. It suggests that the diploid progenitors of this group had $x = 10$, 11 and possibly 12. *Berzelia*, the most specialized genus, most likely has $x = 20$, suggesting aneuploidy from the family base, to $x = 10$ and subsequent polyploidy. Neopolyploidy in the family is restricted to four species of the twenty-two counted, 18%, with one of the polyploids having diploid, tetraploid and hexaploid races.

RELATIONSHIPS

The immediate relationships of Bruniaceae are obscure. The family is usually considered to have broadly Rosalean affinities. Modern phylogenetic treatments vary somewhat but Bruniaceae are generally regarded as one of several unspecialized but not especially primitive families considered to be Rosalean in a broad sense. Taktadjan (1969) and Cronquist (1968) place the family in Rosales while Thorne (1968) assigns it to Rosiflorae-Pittosporales, an order of markedly southern distribution. The treatment by Dahlgren (1975) differs in placing Bruniaceae in Hamamelidanae–Cunoniales. A flavonoid study by Jay (1968) points to the family having an isolated position in Rosales; Bruniaceae markedly lack ellagic acid, characteristic of Hamamelidaceae and Saxifragaceae. A recent study by Carlquist (1978) of wood anatomy supports the traditional placement of the family. However, Carlquist points particularly to relationships, based in wood anatomy, with the Cape endemics Geissolomataceae and Grubbiaceae, families included by Thorne in his Pittosporales.

These families are unfortunately unknown cytologically, and Rosales are cytologically diverse, so that cytology seems unlikely to be of value in determining relationships of Bruniaceae.

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